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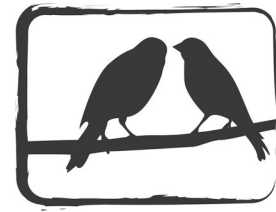
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# Killing in More-than-human Spaces: Pasteurisation, Fungi, and the Metabolic Lives of Wine

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**ABSTRACT** What place might killing occupy in a more-than-human world, where human life is always-already entangled among nonhumans? In this article I attempt to unsettle the assumption that only individual organisms can be killed, and to render other sites and spaces of killing visible. Drawing on ethnographic fieldwork among winemakers in South Australia I examine pasteurisation, a killing practice that acts not on organisms but on the fluids within which they live. Examining the pasteurisation of wine damaged by the fungus *Botrytis cinerea*, I argue that this practice shifts the locus of killing from botrytis' body to metabolic life processes which embrace extracellular enzymes diffused throughout the wine. I suggest that pasteurisation thus displaces killing into spaces, such as wine-in-the-making, within which many metabolic lives coexist and interpenetrate. Pasteurisation therefore renders killing an intervention into the metabolic relationships that tie together numerous species of microbes living within wine. In acting on wine as a whole it kills rather indiscriminately, simultaneously terminating multiple lives that relate to humans in different ways. Pasteurisation therefore both protects and spoils wine, reconfiguring multiple human-nonhuman relationships in conflicting and sometimes economically costly ways. In so doing, it illustrates that in a more-than-human world killing becomes difficult to confine to a single unwanted organism or species. Killing instead becomes disturbingly mobile and communicable, prone to rebound upon the valued human lives of those who kill in unsettling and potentially harmful ways.

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## Introduction

Nathan can tell at a glance that the colour of the Pinot Noir in open fermenter twelve is still slightly wrong. Most of the pigment compounds formerly concentrated in the grape skins which form a floating "cap" atop the fermenting juice have been extracted over ten days of fermentation, and the cap is turning slightly grey. Yet the fluid in the tank below us still looks paler and more watery than a marketable Pinot Noir wine should. But this is only a small tank, and a relatively small problem. This ferment, unlike some of its neighbours, is at least "clean" of the various grape pathogens which have so troubled Nathan and his colleagues in recent weeks. So Nathan, a senior winemaker, can spare open fermenter twelve only a brief and cursory examination squeezed onto the very end of his morning inspection of the winery's processing areas.

This is not the first time I have shadowed Nathan as he makes his daily rounds of his employer's winery, which is located in South Australia's Barossa Valley. I have visited this site

regularly over the past several months as part of a wider ethnographic project examining how the qualities of materials, and the activities of plants and microbes, come to matter within commercial relationships among Australian grape growers and wine producers.<sup>1</sup> While following Nathan and his colleagues over the course of the annual grape harvest I have grown accustomed to the bustle of the tank farm, and to the constant commotion as cellar hands try to work around us. By this particular morning in mid-April 2011, with the harvest drawing to a close, I am even becoming used to the vast scale of Nathan's winery. For this winery requires an exceptionally large processing capacity to fulfil its role as one of the main winemaking facilities for the major corporate wine producer, "The Company,"<sup>2</sup> which owns it.

But this apparently routine morning is about to take an unexpected turn. Instead of returning directly to his office as usual, Nathan leads me past apparently endless ranks of storage tanks until we reach a seldom-visited corner of the winery. Here, several of Nathan's colleagues are gathered around a tangle of shiny stainless steel pipes. They are testing the machine in front of them—fiddling with a control console as they search for a combination of settings which will circulate wine through its heat-exchanger at just the right temperature, and for just the right length of time, to induce flash-pasteurisation.<sup>3</sup>

This is the first time I have encountered an industrial pasteuriser (figure 1)—none of the other, smaller-scale, wine producers with whom I have worked can afford to own such an expensive and seldom-used piece of equipment. Because pasteurisation is, as Nathan explains, emphatically *not* normal winemaking procedure. Pasteurisation spoils the taste and scent of wine, and so this pasteuriser is being used only as a treatment of last resort for wines severely damaged by the fungal diseases that have blighted this year's grape harvest. During the preceding months the state of South Australia experienced its wettest first quarter since official records began,<sup>4</sup> and several rarely encountered grape vine pathogens have flourished amid the incessant rain and exceptionally high humidity. Most common among them is the fungus

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<sup>1</sup> The fieldwork for this piece of research comprised nine months of participant observation during which I work-shadowed and worked alongside viticultural and winemaking staff at several wine companies in South Australia (although in the interests of both brevity and clarity this article focuses exclusively on just one of these companies). During the course of my fieldwork I observed activities including the assessment and harvesting of grapes in the vineyard, the processing of grapes and grape juices into wine, the sorting of wines into quality grades, and the testing of wine for quality and disease contamination prior to bottling. I also conducted over 60 more formal qualitative interviews during the course of this period of field research.

<sup>2</sup> The names of this wine company and of its staff have been replaced with pseudonyms throughout this article in order to maintain the anonymity of its employees. For this article's purposes, it is perhaps sufficient to note that The Company is one of Australia's largest wine producers by volume, and is part of a major beverage conglomerate.

<sup>3</sup> Official definitions characterise pasteurisation as a relationship between temperature and time. High-temperature, or 'flash,' pasteurisation is defined as heating a liquid to 72°C (162°F) for 15 seconds. Heather Paxson, "Post-Pasteurian Cultures: The Microbiopolitics of Raw-milk Cheese in the United States," *Cultural Anthropology* 23, no. 1 (2008): 15–47; Deborah M. Valenze, *Milk: a Local and Global History* (New Haven: Yale University Press, 2011).

<sup>4</sup> Australian Bureau of Meteorology. *Monthly Weather Review - South Australia March 2011*, accessed 21 December 2012, <http://www.bom.gov.au/climate/mwr/sa/mwr-sa-201103.pdf>.

*Botrytis cinerea*, which causes a fast-developing grey rot that has infested numerous vineyards across southeastern Australia throughout the harvest. Infected grapes undergo a series of unwelcome biochemical changes as botrytis colonises them. Developing botrytis mycelia consume the acids and sugars in their juice, ultimately leaving little sugar for yeasts to metabolise into alcohol during fermentation. Meanwhile, and just as problematically, even a partial botrytis infection imbues grape juice with fungal proteins which impart a mouldy, mushroom-like smell that is intensely unpleasant to human wine-drinkers.<sup>5</sup> So a botrytis infection damages grapes in ways that impede the conversion of grape juice into wine and leave human wine producers either accumulating unappetising and possibly unsaleable wine or, worse, producing no wine at all.



**Figure 1** The winery's pasteuriser. Wine enters the machine through the piping on the right and is pumped into a heat exchanger (centre). The pipes within the heat exchanger are surrounded by water, heated in a large boiler (left), which warms the wine to 72°C. On reaching 72°C, the now-pasteurised wine is rapidly cooled before exiting the machine. Photo by author.

<sup>5</sup> Pascal Ribéreau-Gayon et al., *Handbook of Enology Vol. 1, The Microbiology of Wine and Vinifications* (Chichester: Wiley & Sons, 2006).



**Figure 2** Grapes infected with *Botrytis cinerea*. Several grapes in the centre of the bunch display the characteristic grey-green ‘fur’ or ‘felt’ of a mature, sporulating grey rot infection. Photo by author.

### **Pasteurisation, Conflict, and Killing**

A host of meetings and minglings between different forms of life vie for attention within even this briefest of introductory visits to Nathan’s winery. The everyday business of winemaking is quite evidently a multi-species affair, one which mires capital accumulation amid the exigencies of multiple nonhuman metabolisms. So Nathan’s winery immediately presents a landscape saturated with intercorporeal entanglements which immerse human actions and agendas in the doings of fungal and bacterial companions.<sup>6</sup> The human-nonhuman co-constitution and conviviality with which scholars engaged in an ongoing turn to studying more-than-human dimensions of social life—including geographers, anthropologists, sociologists, and practitioners of science studies—are often concerned can, then, be easily

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<sup>6</sup> It should also be noted here that these modes of human-microbial relation are all predicated upon complex relationships with grape vines which pervasively colour the lives of human grape growers and wine producers. Plant life, in the form of the European grape vine (*Vitis vinifera*), is also fundamental to the weaving of this entangled terrain—a point discussed more explicitly in Jeremy Brice, “Attending to Grape Vines: Perceptual Practices, Planty Agencies and Multiple Temporalities in Australian Viticulture,” *Social & Cultural Geography*, advance online publication (2014) doi: 10.1080/14649365.2014.883637.



perceived within the everyday business of winery life.<sup>7</sup> Yet the presence of a pasteuriser hints that even these productive modes of cross-species companionship are neither entirely comfortable nor free from conflict. Because pasteurisation *kills*. Specifically, this lethal form of heat treatment is widely employed to eliminate unwanted microbes from various fluids before they are made available for human consumption.<sup>8</sup>

The pasteuriser's presence in Nathan's winery thus condenses and makes visible antagonistic forms of human-microbial relations. Previous social science accounts have argued that pasteurisation practices "configure microbes as elements to be eliminated so that human politics might be cultivated."<sup>9</sup> So it is due to pasteurisation's status as an emblem of human conflicts with, and the killing of, microbes that this article will focus upon Nathan's winery and upon a pasteuriser. Yet the conflicts at issue here do not quite conform to the familiar opposition between human and microbial flourishing, for they concern two distinct species of fungi—botrytis and yeasts<sup>10</sup>—which both make their living by biochemically transforming grape sugars. It is these fungal species' metabolic incompatibility, their inability to thrive together, that initially makes botrytis a problem for human winemakers like Nathan. Because human winemakers can convert grape juice into wine only by mobilising metabolic and economic alliances with yeasts which convert sugar into alcohol. It is their economic dependence upon yeasts that first pits winemakers against botrytis.<sup>11</sup>

But what might it mean, within this thoroughly more-than-human landscape where human-fungal relations mix conflict with conviviality, to say that pasteurisation kills? It is this paper's aim to ask just what killing might become, and what place it might occupy, within this

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<sup>7</sup> As detailed in Sarah Whatmore, *Hybrid Geographies: Natures, Cultures, Spaces* (London: SAGE, 2002).; Sarah Whatmore and Steve Hinchliffe, "Ecological Landscapes," in *The Oxford Handbook of Material Culture Studies*, ed. Dan Hicks and Mary Carolyn Beaudry (Oxford: Oxford University Press, 2010), 440-458; Jamie Lorimer, "Multinatural Geographies for the Anthropocene," *Progress in Human Geography* 36, no. 5 (2012): 593-612.

<sup>8</sup> A wide variety of liquid foodstuffs are routinely treated using pasteurisation. However, social scientists' attention has overwhelmingly focused on issues surrounding the pasteurisation of milk and cheese, see Paxson, "Post-Pasteurian Cultures"; Gareth Enticott, "Risking the Rural: Nature, Morality and the Consumption of Unpasteurised Milk," *Journal of Rural Studies* 19, no. 4 (October 2003): 411-424; Harry G. West, "Food Fears and Raw-milk Cheese" *Appetite* 51, no. 1 (July 2008): 25-9. One fascinating exception is Law and Mol's exploration of the use of related heat treatment techniques in killing viruses found within pigswill; John Law and Annemarie Mol, "Globalisation in Practice: On the Politics of Boiling Pigswill," *Geoforum* 39, no. 1 (2008): 133-143.

<sup>9</sup> Paxson, "Post-Pasteurian Cultures," 17; see also Bruno Latour, *The Pasteurization of France* (Cambridge, Mass.: Harvard University Press, 1988).

<sup>10</sup> The specific yeast species in question is *Saccharomyces cerevisiae*, also known colloquially as 'brewer's yeast' and 'baker's yeast.'

<sup>11</sup> At least it pits humans against botrytis at this particular site. However, more benign modes of human-botrytis relations are also possible; under different environmental conditions *Botrytis cinerea* may instead develop into 'noble rot.' Unlike grey rot this form of botrytis infection dehydrates grape juice, creating the extremely high sugar and acid concentrations required for the production of certain highly prized dessert wines. Growers may even deliberately inoculate grapes with botrytis to encourage noble rot; Ribéreau-Gayon *et al.*, *Handbook of Enology Vol. 1*; J. Ribéreau-Gayon, Pascal Ribéreau-Gayon, and G. Seguin, "Botrytis Cinerea in Enology," in *The Biology of Botrytis*, ed. J. Coley-Smith, W R Jarvis, and K Verhoeff (London: Academic Press, 1980), 251-274.

world where life is lived amongst and through relations that violate the boundaries of individual bodies and of species. Posing questions about killing through this idiom of interspecies togetherness admittedly constitutes a departure from the concern with the extinguishing of individual human subjects that has characterised most scholarly engagements with death and killing.<sup>12</sup> Yet this deviation from both humanity and individuality is necessary because the pasteuriser's target, *Botrytis cinerea*, is a fungus, and fungi are difficult to characterise as discrete, clearly bounded individuals.<sup>13</sup> Rather, multicellular fungal bodies are composed from a network or mesh of thin tubes of cells, called hyphae. This meandering complex of intersecting tendrils, or mycelium, adapts its shape to environmental conditions<sup>14</sup> in ways that complicate notions of organic individuality. Parts of a mycelium may become cut off from the main body, forming a distinct yet genetically identical entity. Or, in some species, hyphae belonging to different mycelia may fuse together—merging two genetically distinct fungal networks into a single metabolic unit.<sup>15</sup> Fungi are, then, modes of life capable of fragmenting and coalescing in ways that efface fixed boundaries between self and other, between inside and outside, and which resist and unsettle notions of bodily or organic individuality.<sup>16</sup>

The productivity of this paper's engagement with the killing of fungal life through pasteurisation lies precisely in the way that this practice decentres bounded individual subjects, bodies, and organisms. For troubling the association between killing and individuality holds the potential to unsettle several common-sense suppositions about the spatiality and ontology of killing that have tended to both dominate and constrain extant scholarly analyses of death-dealing. The spatial logic of killing which this article aims to question can be readily discerned within the *Oxford English Dictionary's* definition of the verb "to kill" as: "To put to death; to deprive of life; to slay, slaughter. In early use implying personal agency and the use of a weapon; later, extended to any means or cause which puts an end to life."<sup>17</sup> By this intuitively familiar logic, to kill is to cause death, and death in turn involves the withdrawal of life from

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<sup>12</sup> Romanillos' review of the philosophical traditions which have informed geographical treatments of death, for instance, concludes that Western scholarly thought approaches death primarily through the issue of a subject's consciousness of their own finitude. This death-consciousness is typically conceived as a characteristic distinguishing the human from the nonhuman, rendering death in deeply anthropocentric terms; see José Luis Romanillos, "Geography, Death, and Finitude," *Environment and Planning A* 43, no. 11 (2011): 2533–2553. This article takes a different analytical tack, being concerned less with the consciousness of death's inevitability than with its enactment within killing practices.

<sup>13</sup> As Anna Tsing argues in "On Nonscalability: The Living World Is Not Amenable to Precision-Nested Scales," *Common Knowledge* 18, no. 3 (August 2012): 505–524; Anna Tsing, "Unruly Edges: Mushrooms as Companion Species," *Environmental Humanities* 1 (2012): 141–154.

<sup>14</sup> David H. Jennings, and G. Lysek, *Fungal Biology: Understanding the Fungal Lifestyle* (Oxford: BIOS Scientific Publishers, 1999).

<sup>15</sup> *Botrytis cinerea*, the fungus on which this article centres, is one of the species capable of such metabolic mergers; C. T. Ingold, and Harry J. Hudson, *The Biology of Fungi* (London: Chapman & Hall, 1993).

<sup>16</sup> Lynn Margulis and Dorion Sagan, *What Is Life?* (Berkeley: University of California Press, 2000).

<sup>17</sup> *OED Online*, "kill, v." accessed 1 March, 2013. <http://ezproxy.ouls.ox.ac.uk:2277/view/Entry/103361>.

something formerly possessed of it. Killing, by this reasoning, requires the presence of life and may therefore only be visited upon some-thing in which life is already present. Killing is something that is done to *living things*. This may all seem sensible enough, even obvious, but an unquestioning acceptance of this cluster of assumptions—which renders life a property of certain (living) things—produces a very specific understanding of the spatiality of killing. One which presumes that killing acts upon individual organic bodies. Yet while this notion that killing is something that is necessarily done to organisms is deeply ingrained in both popular and scholarly thinking, it is also bound up with a historically specific, and contingent, conceptualisation of life itself. By Foucault's influential account<sup>18</sup> the assertion that life is an attribute found only within organisms, bodies whose parts compose a unified whole or totality of functions which resists death and thus maintains its own vitality, emerged alongside (and constitutes the founding gesture of) the modern life sciences.<sup>19</sup> In rendering life a property of organisms, Foucault contends, biological thinking has located life exclusively *within* organic bodies. The boundaries of individual organisms (the skin, the cell wall) thus come also to mark the spatial limits of life, so that: "The organic becomes the living ... that which produces, grows, and reproduces; the inorganic is the non-living, that which neither develops nor reproduces."<sup>20</sup>

Foucault's account of modern Euro-American thought's sequestering of life within individual organic bodies reserves a particularly intriguing role for death. For to locate life within an organism defined by its striving to defy death and avoid returning to inorganic matter also suggests that "resisting death is ... the definition of life itself."<sup>21</sup> This move positions a capacity to die, and the threat of death, as the hallmark of the living; as that which differentiates and opposes living organisms against non-living things. In thus contending that "only the organism can die"<sup>22</sup> it renders the ability to die, like life itself, a property found within—but not outside—organisms. Life and death thus come to occupy the same space within organic bodies, enabling the death of a body not just to negate but also to diagnose, imply, and make visible its vitality.

Foucault's account describes the emergence of a cluster of neat spatial coincidences between life, death, and the living organism which enact a single grand spatial divide, opposing living organisms against inert non-living (and thus undying, un-killable) things. This gesture of separating and opposing two contrasting domains mirrors the other dualisms (for instance the binaries nature/culture, subject/object, and human/nonhuman) often taken to

<sup>18</sup> In Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (London: Tavistock Publications, 1970).

<sup>19</sup> In the sense that this isomorphism between life and organism both constituted biology's object of study and facilitated its emergence as an autonomous science of life around the beginning of the nineteenth century; see Nikolas S. Rose, *Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-first Century* (Princeton: Princeton University Press, 2007).

<sup>20</sup> Foucault, *The Order of Things*, 232. Foucault's account has heavily influenced subsequent treatments of the relationship between life and the biosciences; see for instance Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors, and Machines* (Cambridge, Mass.: Harvard University Press, 2002); Stefan Helmreich, "What Was Life? Answers from Three Limit Biologies," *Critical Inquiry* 37, no. 4 (2011): 671–696.

<sup>21</sup> Rose, *Politics of Life Itself*, 43.

<sup>22</sup> Foucault, *The Order of Things*, 277; see also Romanillos, "Geography, Death, and Finitude."



underpin modern Western thought.<sup>23</sup> So perhaps it is not entirely surprising that, while Foucault's interest was in the scientific discourse of early biology,<sup>24</sup> echoes of this dualist geography can be discerned within contemporary scholars' mappings both of life's location and of the spatiality of killing, in which individual organic bodies tend to loom large. For even more-than-human scholars' engagements with killing practices—ranging from the exsanguination of sheep and pigs in an abattoir,<sup>25</sup> to the shooting of cattle on a farm,<sup>26</sup> and even the decapitation of a lizard in a suburban garden<sup>27</sup>—follow this grand divide's contours. Despite many differences in target species, site, and method, all these ways of killing have been presented as manifestations of a common spatial logic. All have been figured as the subtraction of life from an individual organism's body—from some-thing within which life resides and on which killing acts.

To map killing onto clearly bounded individual bodies in this manner can do important work. It has, for instance, helped the aforementioned studies to foreground the pain and distress that often attends the killing of animals, and to stress the importance of care for their welfare.<sup>28</sup> But must killing always be this way? Might it be possible to articulate other geographies of killing, ones capable of making space for more-than-individual aspects of fungal life and death? Geographies in which killing could target sites other than the volume enclosed by an individual animal's skin, and could even do entirely different work? Might sustained empirical questioning of where different practices of being-with nonhumans might locate and perform killing even have been elided by the common-sense presumption that killing must act on an organic body? Addressing these questions demands careful consideration of how one might go about asking where, if not within an individual organism's body, the killing enacted by Nathan's pasteuriser might take place.

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<sup>23</sup> In Bruno Latour, *We Have Never Been Modern* (London: Harvester Wheatsheaf, 1993); Val Plumwood, *Feminism and the Mastery of Nature* (London: Routledge, 1993).

<sup>24</sup> It is important to note that the spatiality and ontology attributed to life within the biological sciences has varied dramatically depending on the period and subdiscipline in question; that the life sciences in no way form a monolithic epistemic unity. Nevertheless, it is arguable that for mainstream biologists life remains, broadly speaking, a property of organisms; see Rose, *Politics of Life Itself*; Stefan Helmreich and Sophia Roosth, "Life Forms: a Keyword Entry," *Representations* 112, no. 1 (2010): 27–53; Helmreich, "What Was Life?"; Keller, *Making Sense of Life*; Hannah Landecker, "Food as Exposure: Nutritional Epigenetics and the New Metabolism," *BioSocieties* 6, no. 2 (June 2011): 167–194; Gail Davies, "Molecular Life," in *A Companion to Social Geography*, ed. Vincent J. Del Casino, Mary E. Thomas, Paul Cloke, and Ruth Panelli, (Oxford: Wiley-Blackwell, 2011), 257–274.

<sup>25</sup> Emma J. Roe, "Ethics and the Non-Human: The Matterings of Animal Sentience in the Meat Industry," in *Taking-Place: Non-Representational Theories and Geography*, ed. Ben Anderson and Paul Harrison, (Farnham: Ashgate, 2010), 261–280.

<sup>26</sup> John Law, "Care and Killing: Tensions in Veterinary Practice," in *Care in Practice: On Tinkering in Clinics, Homes and Farms*, ed. Annemarie Mol, Ingunn Moser, and Jeanette Pols (Bielefeld: transcript Verlag, 2010), 57–71.

<sup>27</sup> David Lulka, "The Lawn; or on Becoming a Killer," *Environment and Planning D: Society and Space* 30, no. 2 (2012): 207–225.

<sup>28</sup> Law, "Care and Killing"; Lulka, "The Lawn; or on Becoming a Killer"; Roe, "Ethics and the Non-Human."

## Killing (in) Practices

Bruno Latour's caveat that modernity's characteristic discursive disentangling and purification of two opposed ontological domains is always furtively underpinned by their hybridisation in practice appears to offer some analytical purchase upon these issues. For Latour suggests that the great dualisms are not so powerful after all because in practice we, and the world, have never been modern.<sup>29</sup> In recent decades the hitherto neglected middle ground between nature and culture exposed by Latour and his interlocutors has sprouted a range of theoretical movements, such as more-than-human geographies, vital materialisms and animic ontologies.<sup>30</sup> Such approaches' conceptual heritage has made their adherents highly proficient at undermining dualistic grand divides such as that which isolates organic life within a domain separated from and opposed against that of inorganic non-living things. Indeed, more-than-human geographers have—along with their counterparts in other disciplines—long suggested that life's spatiality isn't (and never was) so tidy; that certain facets of life elude, overflow, and slip between the twin dichotomies of living/non-living and organic/inorganic. Implicit in this stance is an ontological and spatial refiguring which addresses life not as an attribute essential to living things but "as a modality of connection between bodies (including human bodies) and (geo-physical) worlds."<sup>31</sup>

This move has enabled more-than-human accounts to trace a life in motion that inhabits heterogeneous circulations—including metabolic, pathogenic, genetic, and affective exchanges—which traverse the boundaries of organic bodies. By this understanding life is not contained within organisms but distributed throughout currents of material motion that embrace, yet also reach far beyond, the organic.<sup>32</sup> This more-than-human relational life inhabits the spaces in-between organic bodies as much as those enclosed within their confines,<sup>33</sup> intermingling with the material environments within and through which organic

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<sup>29</sup> In Latour, *We Have Never Been Modern*; see also Annemarie Mol, *The Body Multiple: Ontology in Medical Practice* (Durham: Duke University Press, 2002).

<sup>30</sup> On vital materialisms see Jane Bennett, *Vibrant Matter: a Political Ecology of Things* (Durham: Duke University Press, 2010); on animic ontologies see Tim Ingold, *Being Alive: Essays on Movement, Knowledge and Description* (London: Routledge, 2011); on more-than-human geographies see Lorimer, "Multinatural Geographies for the Anthropocene."; Whatmore, *Hybrid Geographies*.

<sup>31</sup> Sarah Whatmore, "Materialist Returns: Practising Cultural Geography in and for a More-than-human World," *Cultural Geographies* 13, no. 4 (2006): 600–609, 603.

<sup>32</sup> Sarah Whatmore, "Biophilosophy," in *The Dictionary of Human Geography*, ed. Derek Gregory, Ron Johnston, Geraldine Pratt, Michael Watts, and Sarah Whatmore 5th Edition. (Oxford: Blackwell, 2009), 57; Bruce Braun, "Environmental Issues: Inventive Life," *Progress in Human Geography* 32, no. 5 (October 2008): 667–679.

<sup>33</sup> This commitment to taking life 'outside of itself' and resistance to its spatial localisation is perhaps the reason for these accounts' sympathy for and affinity with vitalist ontologies of life; see Beth Greenhough, "Vitalist Geographies: Life and the More-Than-Human," in *Taking-Place: Non-Representational Theories and Geography*, ed. Ben Anderson and Paul Harrison (Farnham: Ashgate, 2010), 37–54; Eugene Thacker, "Thought Creatures," *Theory, Culture & Society* 24, no. 7–8 (December 1, 2007): 314–316.

forms take shape.<sup>34</sup> This thoroughgoing spatio-ontological reassembling “challenges prevalent modes of thinking configured around bounded interacting bodies and offers ecologies characterized by flows above, through and below the level of the organism.”<sup>35</sup> Life thus becomes a vector of relation and recombination instead of an essential property of living organisms, which in marking ontological boundaries, opposes the living against the non-living things that compose their environment.<sup>36</sup> This account of life foregrounds associations and continuities between heterogeneous bodies rather than turning differences into divides which isolate. In so doing, it aims to articulate a sociable life that is lived within associations which churn organisms together with non-living bodies.<sup>37</sup>

More-than-human scholars’ deployment of Latour’s critiques of dualism to decentre the individual organism and to foster recognition of more collective aspects and manifestations of life is certainly an impressive achievement. Moreover, this rethinking of life in relational terms has admirably equipped more-than-human approaches for the task of developing non-anthropocentric approaches to killing. But in order to understand the killing that is enacted when Nathan pasteurises botrytised wine I will have to push this line of thought a little further than has been necessary in previous studies. Because practitioners of more-than-human approaches have yet to explicitly consider what kinds of death and of killing might be proper to the more-than-organic life that they describe, tending instead to tacitly reproduce common-sense accounts of a killing that operates on individual animal bodies. But other mappings will be needed if we are to do justice to the diversity and the strangeness of those deaths which come to notice when the business of killing encounters lives that are not human, or even animal.

This article contends that renewing Latour’s attention to dissonances between discourses and practices<sup>38</sup> offers one promising means of negotiating these theoretical tensions, and of developing alternative mappings of killing. This endeavour demands a close empirical attention to how and where killing might be done in practice. Or better, in practices. For to contend that killing is done (and death enacted) in practice implies that if there are different practices then these will likely enact death (and so life) differently, and will locate it within

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<sup>34</sup> Ingold, *Being Alive*; Hayden Lorimer, “Forces of Nature, Forms of Life: Calibrating Ethology and Phenomenology,” in *Taking-Place: Non-Representational Theories and Geography*, ed. Ben Anderson and Paul Harrison (Farnham: Ashgate, 2010), 55–78.

<sup>35</sup> Lorimer, “Multinatural Geographies for the Anthropocene,” 595.

<sup>36</sup> The more-than-human position therefore affirms that things may be involved in, and pertain to, life without *in themselves* being ‘alive’ or being ‘living things’ (in the sense, commonly applied to organisms, that they contain a coherent, self-sustaining, and self-reproducing set of biological functions within themselves). This distinction between ‘liveliness’ and ‘aliveness’—or, to borrow Eugene Thacker’s vocabulary, between ‘life itself’ and ‘the living’—will be important within the discussion that follows. For further discussion of this distinction between ‘life’ and ‘the living,’ see Eugene Thacker, *After Life* (Chicago: University of Chicago Press, 2010).

<sup>37</sup> Myra J. Hird, *The Origins of Sociable Life: Evolution After Science Studies* (London: Palgrave, 2009); Bruce Braun, “Biopolitics and the Molecularization of Life,” *Cultural Geographies* 14, no. 1 (January 2007): 6–28.

<sup>38</sup> Latour, *We Have Never Been Modern*; Mol, *The Body Multiple*.

different spaces.<sup>39</sup> Indeed, medical anthropologists' studies of a different repertoire of death-enacting practices—ways of recognising, establishing, and locating death when working with expiring human bodies—suggest that deaths-in-practice often display such multiplicity.<sup>40</sup> Moreover, they suggest that differences enacted among deaths-in-practice may have profound ethical and political consequences.<sup>41</sup>

So different ways of killing will likely enact, or do, deaths in different ways, in different spaces, and with different effects. Which, if Foucault's observation that life and death reciprocally define and diagnose one another holds good, suggests that different killing practices are liable to produce different enactments of what life is, of life's spatiality, and of what may be counted as living. Killing practices therefore implicitly bring their own geographies of both life and death along with them—geographies that need not necessarily render these processes coextensive with the body of an individual organism. This implies that killing practices are capable of redefining the very conditions of possibility for life. Drawing out the spatialities of killing enacted in different practices, then, becomes a matter of some ethical weight for it promises to provide opportunities to explore how life and death might be enacted differently.

With this point in mind, it is now perhaps time to return to Nathan's winery and enquire afresh into where and how his pasteuriser does its killing. For it is now clear that to ask these questions is also to examine what modes and spatialities of life, and of human-nonhuman relations, might be both made possible and placed at issue through this mode of enacting death; that investigating a killing practice which targets a site other than the familiar contours of a cohesive, neatly-bounded animal body also promises to open up new understandings of life, death, and killing. By enquiring into the how and where of the killing that pasteurisation practices enact, then, I aim to make it possible to ask: what might be the ethical, political, and economic stakes of these antagonistic, and even exterminatory, ways of being-with the nonhuman?

### Death of an Enzyme?

Yet even while surrounded by the microbial abundance of Nathan's winery, it seemingly remains difficult to think and to talk about where, how, or indeed whether pasteurisation kills. Because until I encountered Nathan's pasteuriser I had assumed that winemakers had little

<sup>39</sup> This point is elaborated at length in Mol, *The Body Multiple*; John Law, "Collateral Realities," in *The Politics of Knowledge*, ed. Fernando Dominguez Rubio and Patrick Baert (London: Routledge, 2011), 156-178; Marianne Elisabeth Lien and John Law, "'Emergent Aliens': On Salmon, Nature, and Their Enactment," *Ethnos* 76, no. 1 (2011): 65-87.

<sup>40</sup> Hadders' work in intensive care units and Lock's studies of 'brain death' illustrate that different ways of establishing whether a body is alive or dead often yield differing conclusions. ECG monitors may, for instance, show signs of life in a body whose pulse has ceased, while bodies may remain alive by cardiological measures after months or years of 'brain death.' Hans Hadders, "Enacting Death in the Intensive Care Unit: Medical Technology and the Multiple Ontologies of Death," *Health* 13, no. 6 (November 2009): 571-87; Margaret Lock, "On Making Up the Good-as-Dead in a Utilitarian World," in *Remaking Life & Death: Toward an Anthropology of the Biosciences*, ed. Sarah Franklin and Margaret Lock (Oxford: James Currey, 2003), 165-192.

<sup>41</sup> Margaret Lock illustrates this point with regard to the procurement of organs for transplant from 'brain-dead' bodies in Lock, "On Making Up the Good-as-Dead."

need to kill botrytis; it had appeared to simply fade away after infected grapes entered a winery. Pressing separates the grape skins on and within which botrytis hyphae mainly reside from grape juice, and most stray fungal cells are later extracted from wine during routine filtering and centrifuging. So normal winemaking procedure had appeared to separate botrytis from wine so successfully that human winemakers would never need to actively kill it.<sup>42</sup>

So I am initially confused by Nathan's interest in pasteurising wine which, while far from a finished product, has already completed alcoholic fermentation and undergone pressing and centrifuging. Any botrytis should surely have died long before this wine reached the pasteuriser. I question Nathan, and he agrees that this is true—but botrytis is not the pasteuriser's target. The point of pasteurising this wine is, instead, to rid it of laccase, an oxidative enzyme produced by botrytis. Laccase, says Nathan, oxidises tannins and anthocyanins, phenolic compounds found in grape skins that have anti-fungal properties. This helps botrytis hyphae to survive, breach grape skins, and reach the juice inside the berry's flesh. These hyphae excrete laccase into the grape tissue around them during infection, so this extracellular enzyme is found primarily within grape, rather than botrytis, tissues. So laccase tends to linger on in grape skins and juice long after its parent mycelium has been removed.<sup>43</sup> This lingering-on causes trouble for Nathan because tannins and anthocyanins are also pigments that affect the colour of wines, and especially of red wines. Red wines oxidised by laccase quickly turn brown, and a greasy film forms on their surface.<sup>44</sup> This transformation, although harmless to human health, is far from visually appealing and brown wine is, Nathan explains, considered by most wine producers to be unsaleable. So wines contaminated with laccase remain at constant risk of decomposing on exposure to air, and therefore of becoming effectively worthless, for as long as this enzyme remains active.

Nathan is therefore keen to kill off any laccase present within his company's wines before it can effect this costly colour change. But, he explains, laccase is frustratingly difficult to kill; it is tricky to deactivate, destroy, or remove from the wine.<sup>45</sup> About the only treatment that does consistently and permanently remedy laccase contamination is pasteurisation. So with this machine, Nathan tells me, "Hopefully we can kill the laccase in this wine." He stops, visibly annoyed with himself. "Well, of course we can't really *kill* laccase. It's an enzyme, it

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<sup>42</sup> In this respect the experience of winemakers contrasted sharply with that of grape growers, who would have liked to kill the botrytis infesting their vineyards but found themselves largely unable to do so. In vineyards, botrytis spores tended to lie dormant, remaining difficult to detect, until the grapes approached sugar ripeness. At this point, the spores would erupt into a grey rot which spread so rapidly that it often rendered the crop unsaleable before grape growers were able to apply pesticide sprays or harvest their grapes.

<sup>43</sup> Ribéreau-Gayon *et al.*, *Handbook of Enology Vol. 1*; Alexander Schouten *et al.*, "Resveratrol Acts as a Natural Profungicide and Induces Self-intoxication by a Specific Laccase," *Molecular Microbiology* 43, no. 4 (February 2002): 883–94.

<sup>44</sup> This phenomenon is known as oxidative cassé.

<sup>45</sup> Laccase is largely unaffected by commonly-used preservative compounds, highly chemically stable, and too small to extract from wine through standard filtration and centrifuging methods; Ribéreau-Gayon *et al.*, *Handbook of Enology Vol. 1*.



isn't alive. Hopefully we can denature the laccase ..."<sup>46</sup> Suddenly I realise for the first time that Nathan has already mentioned 'killing laccase' several times during our conversation. This phrase has become all too familiar during weeks of discussions with other winemakers similarly anxious about their own laccase-contaminated wines. So familiar that until Nathan corrected himself I had ceased to notice an implicit contradiction: that only living things can be killed, but enzymes are not living things.

So something about the kind of death-dealing being enacted through pasteurisation in Nathan's winery does not quite fit with Nathan's, or my own, habitual conceptions of what and where killing might be. When Nathan tries to describe the kind of killing that pasteurisation does in winemaking practice, his words betray him. He finds himself discussing the killing not of a living organism but of an enzyme in his wine. An enzyme which, Nathan tells me, is not alive.<sup>47</sup> Which cannot be killed, for only things endowed with life can die. In this way, Nathan's momentary disagreement with himself makes visible a very Latourian dissonance between his discursive treatment of killing and his enactment of it within pasteurisation practices.<sup>48</sup> It exposes aspects of the killing being done in this practice which escape and distort Nathan's efforts to locate them within a dualist cartography which places life within, and visits killing upon, organisms.

### Death of a Fungus?

Nathan's rather unusual professional background suggests that there is good reason to take this dissonance, and the paradoxical killing-in-practice which it renders visible, seriously. Nathan used to work in the laboratories of a major oenological research institute, and has even co-authored a textbook on wine biochemistry. So he is clearer than most winemakers about precisely what, microbiologically speaking, pasteurisation does. This technical clarity leaves Nathan facing a simple choice: either pasteurisation targets enzymes or it kills. It cannot do both. And Nathan chooses enzymes over killing. But not immediately. Something about pasteurisation tempts even Nathan—if only briefly—to speak of killing. And Nathan is not alone in this; I have often heard other winemakers speak of pasteurisation as 'killing laccase.'

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<sup>46</sup> Denaturing means, in chemical terms, that the heat applied during pasteurisation alters the molecular structure of the enzyme's active site, preventing it from binding to phenolic molecules and rendering it chemically inactive.

<sup>47</sup> By most definitions an enzyme is a protein molecule which acts as a catalyst for chemical processes within a living organism (although as I will argue below, a focus on fungi complicates the assumption made within this definition that enzymes must be situated within living organisms because their functioning pertains to life processes), and regulates the rate at which life-sustaining chemical reactions proceed. Enzymes are therefore crucial participants in the processes that sustain life. However, they are not usually considered to be living things by biological definitions because enzymes in isolation do not display the capacities—most fundamentally to maintain an autonomous metabolism and to reproduce themselves—through which most contemporary definitions qualify entities as living. See John Dupré and Maureen A O'Malley, "Varieties of Living Things: Life at the Intersection of Lineage and Metabolism," *Philosophy & Theory in Biology* 1 (2009): 1–24; Margulis and Sagan 1995, *What Is Life?*; Pier Luigi Luisi, "ABOUT VARIOUS DEFINITIONS OF LIFE," *Origins of Life and Evolution of the Biosphere* 28, (1998): 613–622.

<sup>48</sup> Latour, *We Have Never Been Modern*; Mol, *The Body Multiple*.

Nathan may be an exceptional and isolated case, but this is not because he speaks of killing laccase. Nathan is exceptional because he corrects himself.

But how to achieve more than a fleeting glimpse of that other enactment of killing which seems so hard to accommodate within words shaped around an ontology of living things, the one performed during pasteurisation? Perhaps paying close attention to Nathan's words is a good way to begin because, in telling me that "Hopefully we can kill the laccase in this wine," he has already explained quite a lot about this other killing. He has even described precisely the space in which pasteurisation performs its killing—and this site is coextensive neither with an organism (botrytis) nor an enzyme (laccase) but with a fluid (the wine circulating through the pasteuriser). Nathan's statement discloses something interesting about the way that pasteurisation enacts death, because wine is not an organism; it is no more a living thing than is laccase. So if pasteurisation is a killing practice which acts on fluids then it follows that pasteurisation always kills by acting on non-living (or at least more than just living) things. Even when pasteurisation targets an organism—bacteria in milk to take a familiar example<sup>49</sup>—it is not this organism alone but the liquid which it inhabits that is actually heat-treated.

Pasteurisation, then, profoundly alters the spatiality of killing, unmooring it from its presumed isomorphism with discrete living things. It enacts a killing that overflows its target bodies, whether organisms or enzymes, acting outside and in-between their boundaries to embrace the fluid which contains them. But when pasteurisation targets laccase in Nathan's winery it seems to go beyond overflowing and utterly divorce the spatiality of killing from that of living bodies, for this fluid contains no botrytis organisms at all. It is this move that so exasperates Nathan, for it leads to the apparently absurd conclusion that pasteurisation must enact death, and therefore position life,<sup>50</sup> among non-living things.

But this same spatial paradox also offers clues about the ontology of the lives which pasteurisation practices place at stake. Because noting that Nathan's pasteuriser enacts a killing which is more firmly located within fluids than within organisms draws attention to laccase's dogged spatial association with grape tissues that become wine. This association is so tenacious as to make laccase more inseparable from wine than from its parent botrytis mycelia. And as Nathan explained earlier, this spatial relationship between laccase and grape tissue does something. Laccase, by infiltrating into grape skins, counters the berry's chemical defences and assists developing botrytis hyphae in reaching the sugar-rich grape juice on which they feed.<sup>51</sup> Moreover, microbiological research suggests that one form of laccase interacts with resveratrol, a phenolic compound found in unripe grapes, to produce a toxin that restricts the growth of botrytis. Laccase may thus regulate the mycelium's development and metabolic relationship with its host by inhibiting growth and maturation until the grape's flesh ripens enough to provide botrytis with an easily digestible, sugary food source.<sup>52</sup>

<sup>49</sup> See Paxson, "Post-Pasteurian Cultures"; West, "Food Fears and Raw-milk Cheese."

<sup>50</sup> As discussed in Foucault, *The Order of Things*; Rose, *Politics of Life Itself*.

<sup>51</sup> Ribéreau-Gayon *et al.*, *Handbook of Enology* Vol. 1.

<sup>52</sup> As described in Schouten *et al.*, "Resveratrol Acts as a Natural Profungicide." These authors speculate that this process may in fact aid the dispersal of grape seeds, establishing a symbiotic relationship between 'pathogen' and host. If so then Schouten *et al.*'s findings would imply that botrytis'

So laccase's incursion into grape skins facilitates and regulates botrytis' metabolic relations with its host, first by restricting mycelial growth until the berry is ripe and later by enabling hyphae to rapidly invade ripe grape skins and flesh. This extracellular enzyme mediates botrytis' metabolic activities from outside of its organic body. Such arrangements are commonplace among fungi, which metabolise by excreting a cocktail of enzymes that convert their surrounding material environment into ready-digested nutrients which their hyphae can simply absorb.<sup>53</sup> For fungi, metabolism—the constellation of interdependent chemical interactions through which a living organism takes in and transforms externally derived sustenance to obtain the energy and materials which sustain its structure and life processes<sup>54</sup> —largely takes place outside of the mycelial body. Fungal metabolic processes are, then, far from spatially isomorphic with fungal organisms.<sup>55</sup>

So the pasteuriser's enactment of death, in targeting an extracellular enzyme located within wine, acts upon a life that occurs amid botrytis' partly externalised metabolism. This shift from living things to metabolic life processes profoundly alters life's spatiality. It renders life identical and coextensive with a constant material traffic between organism and environment. With the continual folding of non-living matter into living bodies that composes and sustains individual organisms, rather than with those recognisably living bodies alone. This move, it might be noted, is entirely compatible with the work of relationally focused theorists and philosophers of biology who identify life with "chemical activity, the movement of molecules."<sup>56</sup> This metabolic account figures life as something somewhat distinct from living things, something always partially outside the organism,<sup>57</sup> for such life resides in the circulation of molecules (which remain non-living things if considered 'in themselves') across organic bodies' boundaries.<sup>58</sup>

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relationships with the grape vines on whose fruit it lives carry a very different tone and valence than its entanglements with the vines' human familiars.

<sup>53</sup> In this respect fungal biology contrasts sharply with that of animals, which localise their metabolic processes within their bodies' boundaries and must ingest foodstuffs before transforming them into biochemically useable substances. Jennings and Lysek, *Fungal Biology*; Ingold and Hudson, *The Biology of Fungi*.

<sup>54</sup> See Hannah Landecker, "Food as Exposure"; Dupré and O'Malley, "Varieties of Living Things," *Philosophy & Theory in Biology* 1 (2009): 1–24.

<sup>55</sup> Margulis and Sagan, *What Is Life?*; Anna Tsing, "Arts of Inclusion, or, How to Love a Mushroom," *Australian Humanities Review* 50 (2011): 5–21.

<sup>56</sup> Margulis and Sagan, *What is Life?*, 17. See also Lynn Margulis and Dorion Sagan, *Acquiring Genomes: a Theory of the Origins of Species* (New York: Basic Books, 2003); Dupré and O'Malley, "Varieties of Living Things"; Jakob Arnoldi, "Autopoiesis," *Theory, Culture & Society* 23, no. 2–3 (May 2006): 116–117.

<sup>57</sup> This distinction reprises the differentiation of 'life' from 'the living' introduced in Thacker, *After Life*.

<sup>58</sup> It is therefore perhaps unsurprising that metabolic processes' blurring of the boundaries between organism and environment, and between living and non-living, has often also been invoked as an exemplar of the relational cartographies of life advanced by more-than-human geographies and related theoretical movements; see Bennett, *Vibrant Matter*; David Goodman, "Agro-Food Studies in the 'Age of Ecology': Nature, Corporeality, Bio-Politics," *Sociologia Ruralis* 39, no. 1 (1999): 17–38; Ingold, *Being Alive*; Landecker, "Food as Exposure."

In enacting a killing that addresses laccase, then, the pasteurisation practised in Nathan's winery precipitates a substantial spatial and ontological redistribution of life. By encompassing both mycelium and extracellular laccase within life processes that bring botrytis and its host grapes into metabolic relation, rather than locating life within these things individually, it blurs the boundaries dividing living from non-living things.<sup>59</sup> Situated within these vital metabolic relations, the laccase which Nathan and his colleagues target when they pasteurise their wine ceases to be just a lone non-living molecule. It is re-entangled within a sprawling web of biochemical encounters and transformations which disperses fungal life first into grape tissues and later throughout the juice and wine extracted from them.

So considered metabolically, the laccase which persists in Nathan's wine becomes an orphaned fragment of an unwanted pathogenic life process. Carrying-on within grape tissues, the metabolic processes that laccase transacts are not ended by the pressing, filtering, and centrifuging which extracts fungal cells from wine. This merely tears them asunder from their parent mycelial bodies. These metabolic vestiges are tricky to locate within the great dichotomy between living and non-living things. They do not quite add up to a living, organic whole.<sup>60</sup> Yet neither are they quite dead *enough*, for these remnants of fungal life remain stubbornly active within the wine; still breaking down tannins and anthocyanins, still sustaining an absent organic body. The laccase in Nathan's wine, then, manifests a partial metabolic afterlife of botrytis. It maintains a mutilated fragment of life process that continually threatens to entangle the wine in a defunct fungal organism's unsavoury metabolic activities.

So perhaps pasteurisation does not kill an enzyme but instead visits death upon aspects of botrytis' metabolic life that overflow and refuse confinement within things, whether these be organisms or enzymes. Perhaps it kills a life that resides not within skins, membranes, and cell walls but in relations between organisms; in the excretion of proteins, the interplay of enzymes, and the absorbing of sugars. This life is not vulnerable to killing techniques that act only on the body of botrytis, on living things within Nathan's wine, for it partially resides beyond the mycelium. So if Nathan is to render his fungal adversary metabolically dead, and to effectively protect his wine from oxidative browning, then his killing practices will need to encompass the spaces within which extracellular enzymes conduct botrytis' metabolic life. Pasteurisation, then, kills because it follows laccase into grape tissues and into the wine made from them.

So the killing enacted when Nathan pasteurises his wine consists less in subtracting life from discrete individual bodies than in intervening in the flows of energy and materials that transact alimentary relationships between them. It distorts and thus blocks enzymatic interactions that transform grape tissues in ways that nourish botrytis. This, then, is a form of

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<sup>59</sup> Such a spatial redistribution is also consonant with the relational accounts of life characteristic of more-than-human and allied approaches, summarised by Tim Ingold as the proposition that "things are in life rather than life in things"; Ingold, *Being Alive*, 29. See also Whatmore, *Hybrid Geographies*; Lorimer, "Multinatural Geographies for the Anthropocene."

<sup>60</sup> In that fungal extracellular enzymes can neither reproduce themselves nor maintain the biochemical transformations which give rise to them in isolation from their parent mycelium. For more on definitions of biological life see Dupré and O'Malley, "Varieties of Living Things"; Margulis and Sagan 1995, *What Is Life?*; Luisi, "About Various Definitions of Life."

killing whose spatiality spans boundaries not only between organism and environment, living and non-living, but also between botrytis and grape. Pasteurisation protects Nathan's wine successfully because this mode of killing, like laccase, operates at and on an interface between species. So perhaps the geography and ontology of killing enacted when Nathan pasteurises his wine complements more-than-human mappings of life as "the network of relations that always take the living organism outside itself."<sup>61</sup> Maybe it is possible to argue that the pasteurisation enacted in Nathan's winery does killing in and for a more-than-human world in which neat boundaries and grand divides do not hold. One where circulations that forge associations between different bodies, spaces, and even species take precedence over boundaries which enclose life within living things. But this collapsing of dualisms should not be taken as an end in itself. Rather, this spatial and ontological refiguring of killing as an intervention into inter-species metabolic relations holds significance because it affects—and puts into question—what is done by, and what is at stake in, killing.

For Nathan and his colleagues, the stakes of pasteurisation are clear enough: laccase contamination jeopardises their wine's palatability to human consumers. Their primary concern is that pasteurisation should, by denaturing laccase, avert the metabolic relations between laccase and phenolic compounds that effect oxidative browning. In short, Nathan expects this mode of killing to restore the wine's suitability for human consumption. To resolve a metabolic incompatibility between humans and botrytis in the humans' favour. So by disrupting the metabolic relations that support the life of botrytis, pasteurisation also renders alternative interspecies carnal intimacies—and specifically the ingestion of wine into human bodies—possible.

Protecting wine's palatability to human bodies is crucial for Nathan and his colleagues. If pasteurisation can prevent oxidative browning then human consumers may be willing not only to drink their wine but also to pay for this privilege. So pasteurisation reconfigures not just metabolic but also economic relations, enabling Nathan's wine to take on a monetary value that the action of laccase would otherwise nullify. Pasteurisation's metabolic killing of fungi thus also makes new relationships among humans possible. It enables Nathan's employers to sell formerly contaminated materials to wine distributors and retailers, who will in turn sell them on to consumers. This killing that travels beyond its target organism also enables Nathan's wine to circulate through the global wine trade, and thus enables The Company to engage in profitable commercial transactions. Transactions which will also mobilise money, helping to fund Nathan's salary and next year's harvest—sustaining the metabolic and commercial entanglements among humans, vines, and microbes which support Nathan's own livelihood.

### **The Death of Wine?**

This is one account of what killing does when Nathan's pasteuriser enacts it as an intervention into inter-species metabolic relations. It secures human bodily (and thus economic) relations with wine by prohibiting incompatible metabolic intimacies with botrytis. It institutes anew the familiar opposition between those socio-economic (and intercorporeal) relations that compose human life and a microbial life inimical to them.<sup>62</sup> But the struggle against botrytis is not the

<sup>61</sup> Whatmore, "Biophilosophy," 47.

<sup>62</sup> As elaborated in Latour, *The Pasteurization of France*; Paxson, "Post-Pasteurian Cultures."



only human-microbe relation at stake when killing is performed upon Nathan's wine. This wine is also inhabited by yeasts left over from alcoholic fermentation, lactic acid bacteria,<sup>63</sup> and perhaps other microbial interlopers. A multitude of grape enzymes, orphaned fragments of the host plant's own metabolism, also remain active alongside laccase and other extracellular remnants of botrytis. Wine in the making is therefore a zone of intense metabolic sociability, one cohabited by multiple metabolic life processes belonging to grapes, bacteria, and fungi. Nathan's wine is a space where metabolisms tangle and interpenetrate; where multiple modes of life occur within and in-between one another.

What is more, Nathan's wine does not simply serve as a container or an inert backdrop to the various collaborative and competitive relations among its inhabitants' entangled metabolisms. Grape juice becomes wine because the metabolisms of yeasts and lactic acid bacteria recompose grape tissue. The intertwining of life processes that occurs as several species' metabolisms intersect, clash, combine, and remake one another defines what Nathan's wine is and becomes. Indeed, winemakers who speak in less meticulously scientific terms than Nathan often assert that wine is this tangle of metabolic life.<sup>64</sup>

So these lively interspecies metabolic entanglements extend throughout and constitute wine; they compose and define the fluid, and the space, within which the pasteuriser enacts its killing. Indeed it is precisely because pasteurisation's spatiality is coextensive with, and applies heat treatment throughout, Nathan's wine that it can kill the metabolic life of botrytis. Yet although this spatial expansiveness enables pasteurisation to pursue laccase across species, this also renders the killing that it enacts rather indiscriminate. Because pasteurisation, in traversing and dissolving the boundaries separating organisms and species, denatures and disrupts not only laccase but also the bacterial, yeast, and grape metabolisms with which it cohabits. The intertwining among species that are characteristic of winemaking mean that pasteurisation cannot avert laccase's damaging activities without simultaneously visiting death upon the many *other* lives which take place alongside it, and which compose a developing wine.

The death of yeasts and lactic acid bacteria is, then, an inevitable but also unintentional outcome of the geography of killing that Nathan's pasteuriser enacts. These unsought killings might, drawing on Law's notion of collateral realities,<sup>65</sup> be termed collateral killing. This mode of killing is an incidental side-effect of pasteurisation; a price that must be paid in order to rid wine of laccase. Nevertheless, this collateral killing has effects. Most importantly for Nathan, it affects his wine since materials only become wine at and through the intersection of multiple species' metabolic lives; lives which largely cease if their molecular constituents are heated to 72°C and the metabolic transformations which sustain them are disrupted. Which means that although pasteurisation leaves wine laccase-free, it also leaves it lacking something. Most obviously it lacks yeasts and lactic acid bacteria, although this may be remedied by re-

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<sup>63</sup> Which will, if permitted, later effect a secondary fermentation by metabolising malic acid into lactic acid. Malolactic fermentation is commonly encouraged in red wines and in white wines undergoing barrel-maturation, but is not usually permitted in wines made from 'aromatic' white grape varieties.

<sup>64</sup> Much as raw milk and unpasteurised cheese—fluids which, like wine in the making, display considerable microbial diversity—are considered by some of their producers and consumers to be in some sense alive; see Paxson, "Post-Pasteurian Cultures"; Enticott, "Risking the Rural."

<sup>65</sup> Law, "Collateral Realities."

inoculating the wine with commercially produced starter cultures. But it also lacks the grape enzymes and other microfauna with which they live and metabolise, and these cannot be replaced. The killing enacted by pasteurisation leaves the metabolic community which composes wine somewhat impoverished. Deadened, in a sense.<sup>66</sup>

This creates a new problem for Nathan, because it means that the collateral killing performed by pasteurisation will affect the composition and qualities of the end product that his employer has to sell. And many of its effects are unwelcome. Winemakers view pasteurisation as diminishing a wine's sensory appeal. Pasteurised wine will never quite achieve the richness and range of flavour and scent that it could have had; it will never be as good as it could have been. Which means that pasteurisation also intervenes in the wine's capacities for corporeal and economic entanglement with humans, as Nathan later explained in an interview: "Even if it's your absolute best Coonawarra<sup>67</sup> Cabernet that's got 12% [of its grapes infected with] botrytis and got pasteurised, ... it's probably gonna drop 3 or 4 out of the 5 [quality] tiers. So, even if it's super-premium ... probably it just about will make bottle quality, if we can pasteurise it in time, but it's gonna be lucky."<sup>68</sup>

In denaturing laccase pasteurisation renders otherwise undrinkable, and therefore worthless, wine suitable for metabolic and economic entanglement with wine distributors and consumers. But it only permits certain attachments to humans. Pasteurisation's decimation of the metabolic communities which compose wine renders heat-treated material suitable only for relatively simple products; wines whose target consumers do not expect too much by way of quality or complexity of flavour. So pasteurised wine is usually blended into less-prestigious, and relatively low-priced, products. As Nathan explains, the changes wrought by pasteurisation's collateral killing can render even super-premium Cabernet Sauvignon, intended for an exclusive and expensive fine wine, fit only for a commercial market blend that offers his employer a negligible profit margin. Wines which were of less outstanding quality before pasteurisation are likely to be relegated to even cheaper products sold in four-litre casks, or to be sold off in bulk. So the collateral killing which pasteurisation enacts alongside its denaturing of laccase also makes an unwelcome difference to Nathan's wine's ability to enter into associations with human bodies. In degrading the quality of the wine it imbricates Nathan's employers in different, and less lucrative, economic associations with wine distributors and consumers. In so doing, pasteurisation also makes the bodily relations established among humans, grape vines, yeasts, and bacteria during wine production more economically precarious.

So while pasteurisation certainly enacts a killing that intervenes in relations between humans and nonhumans, these relations—and the results of its intervention—are not all alike.

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<sup>66</sup> Pasteurisation induces similar collateral changes in milk—killing the various non-pathogenic microbes which inhabit it, denaturing many of its enzymatic components, and destroying the vitamin C found within it; E. Melanie DuPuis, *Nature's Perfect Food: How Milk Became America's Drink* (New York: New York University Press, 2002); Valenze, *Milk*; West, "Food Fears and Raw-milk Cheese." Proponents of raw milk therefore sometimes describe pasteurised milk and cheese as 'dead'; see Paxson, "Post-Pasteurian Cultures"; Peter W. Atkins, *Liquid Materialities: a History of Milk, Science and the Law* (Farnham: Ashgate, 2010).

<sup>67</sup> Coonawarra is a wine region in southeastern South Australia with a reputation for producing high quality Cabernet Sauvignon grapes.

<sup>68</sup> Interview, May 2011.

The collateral killing of yeasts, lactic acid bacteria, and grape enzymes damages Nathan's wine while the denaturing of laccase protects it. So Nathan's relationship with pasteurisation, a mode of killing that simultaneously both serves and harms his employer's economic interests, is an ambivalent one. Nathan must carefully weigh the costs of downgrading high-quality wines into mass-market blends against the risk that laccase may decompose contaminated wine into a worthless brown sludge, and the least damaging course of action is not always clear.

This economically ambivalent modulation of human-nonhuman relations is intimately connected with the space in which pasteurisation kills—a space coextensive not with any individual organism but with wine itself. This practice enacts death throughout a zone where multiple species' metabolic life processes tangle, interpenetrate, and co-constitute one another. It thus produces a form of killing which travels indiscriminately between species, intervening simultaneously in many nonhuman life processes which cohabit within the same space but relate to humans in very different ways. This propensity to traverse bodies and species enables pasteurisation to protect wine by ending botrytis' metabolic life. Yet it also produces unwanted collateral killing as pasteurisation's effects overflow its target, killing all the modes of life which inhabit and co-constitute wine. In disrupting the metabolic lives of the yeasts and lactic acid bacteria upon which human wine producers' livelihoods depend, this collateral killing also reconfigures economic relationships among humans. It inflicts financial losses upon the very wine producers whose assets and interests it was supposed to protect. So when Nathan pasteurises wine, the metabolic killing of botrytis reverberates and rebounds through the intercorporeal fabric of more-than-human life until it returns to burden the same winemakers who performed it. And yet the very carnage that this collateral killing creates as it travels also draws attention back to a metabolic life that generates complex intercorporeal connections between bacteria, fungi, plants and humans. It reaffirms that in a more-than-human world, where different species' lives are inseparably interwoven and even enemies cohabit, killing cannot be easily confined within individual organisms.

## Conclusions

This article has mobilised an ethnographic study of pasteurisation in practice to unsettle the presumption that killing practices need necessarily operate within a sharp dichotomy separating living (and killable) organic bodies from non-living things. In so doing it has attempted to make space both for renewed enquiry into what killing might become when it is visited upon more-than-human lives, and for questioning of what modes of human-nonhuman relations might be enacted through the killing of radically other-than-human entities such as fungi. In attending to Nathan's enactment of killing through the pasteurisation of laccase-contaminated wine, I have attempted to describe a killing practice which generates a spatial logic of death quite different from the familiar subtraction of life from individual animal bodies. The killing performed when Nathan pasteurises wine targets the metabolism of *Botrytis cinerea* rather than its mycelial body, enacting death by disrupting the intercorporeal entanglements through which this fungus lives. The metabolic processes within which this life resides overflow botrytis' bodily boundaries to encompass extracellular enzymes, and so the killing practised through pasteurisation confronts a metabolic life whose spatiality extends beyond the

fungus organism. Pasteurisation enacts a killing whose spatiality matches this life's more-than-organic geography by acting throughout the wine within which botrytis' metabolic life partially takes place. Pasteurisation thus enacts a mode of killing, and describes a metabolic life, whose spatiality unsettles dualistic divides between the living and the non-living, and between organism and environment.

Yet shifting the locus of killing to encompass the metabolic entanglements that permeate and constitute wine does more than simply collapse dualisms. Pasteurising wine enacts killing throughout a space where several species' metabolic lives meet and intertwine, rendering killing an intervention into multiple inter-species—and specifically human-nonhuman—relations. This account of a killing that traffics between organisms and species, rather than remaining confined within their boundaries, resonates with an emphasis upon bodily porosity. I therefore suggest that this killing practice enacts, and is enacted within, worlds saturated with more-than-human intercorporeal entanglements.

This shifting of killing into spaces where boundaries give way to relations and human economies become enmeshed within nonhuman life processes alters the implications of visiting death upon nonhumans. A killing which habitually travels beyond its target organism and species brings unfamiliar hazards and concerns. For pasteurisation, by enacting killing in a space inhabited by multiple metabolic lives that exhibit wildly different relationships with human winemakers, modulates human-nonhuman relations in contradictory ways. This shared spatiality renders the denaturing of laccase, which prevents costly metabolic intimacies between wine and botrytis, inseparable from a damaging collateral killing of the grape tissues, yeasts, and lactic acid bacteria upon which winemakers' livelihoods depend. This is a mode of killing that modifies winemakers' relationships with the various nonhuman lives which compose their wine in surprisingly ambivalent ways. Which both saves and spoils wine and, in so doing, both enables and restricts the economic circulations that sustain wine producers' livelihoods.

So in the more-than-human spaces of winemaking, where conflict is not easily disentangled from coexistence and adversaries often cohabit, the killing which pasteurisation enacts cannot intervene in a simple or singular human-nonhuman relationship. The metabolic lives that inhabit wine are too many, too varied, and too tightly tangled for killing to remain confined within a single target organism or species. The killing enacted when wine is pasteurised instead traverses a complex knotting-together of metabolic and economic interdependencies which renders alimentary relations among nonhumans integral to human lives and livelihoods. This thorough meshing-together effaces any easy separation of human killers from the nonhumans being killed, and the effects of killing rebound upon wine producers in unintended, ambivalent, and in some respects unwelcome ways. This article therefore suggests that to articulate a more-than-human geography of killing is to confront the possibility that killing may be as mobile, as sociable, and as communicable as is more-than-human life. The more-than-human is thus an unsettling register in which to address killing, for it proposes that killing is not easily confined within the individual bodies at which it is targeted. Instead it offers a disturbing vision of killing as a vector of interspecies corporeal intermingling, in which the enactment of death upon nonhumans returns to permeate and modify the future conditions of valued human lives.

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